A case study of the guidance for experiment with "Interactive Experiment Notebook" (IV)
− Utilization of Prediction & Verification Sheets and Trial of Remote Experiment−

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Abstract

In science and engineering education, many student experiments are conducted to confirm laws and learning techniques. However, because of this, student experiments have a "passive" character for students. Students are evaluated based on the results of their reports, but the ``systematic guidance of lab notebooks'', which is the basis of their reports, is often not implemented. However, it is important from the point of view of the "recording and thinking tool" that students write notes on the spot during experiments. Until now, we have been aiming to cultivate literacy accompanied by logical thinking and problem awareness through notebook instruction. In other words, we have tried to convert student experiments, which have a passive character, into an active character through laboratory notebook guidance, and have presented the results several times. Therefore, this time, we made the following two new attempts in the electrical and electronic experiment subjects for senior students of the Department of Electrical and Electronic Engineering. In other words, 1) The use of a preliminary study sheet on experiment content and safety, and 2) A remote experiment attempt to respond to the Covid-19 disaster. In 1), before the experiment, the students consider the contents described below and write them down on the sheet. That is, "specifically, possible troubles (especially safety) that may occur in experiments and how to deal with those troubles" and "matters to be noted when conducting experiments and countermeasures against them, etc." Each student then brings the completed sheet to the experimental team. Then, based on each other's sheets, the experiment team members complete the "experiment content and safety preliminary review sheet" as a team. During the experiment, the students will post this sheet and share information. Through this trial, we will develop the ability to perceive and consider various possibilities in advance and respond to them. Regarding 2), the student experiment team will be divided into two groups, one of which will experiment, and the other will remotely instruct the experiment and analyse the data. The two groups will use the remote tool "Microsoft teams". This will ensure as much social distancing as possible. At the same time, we aim to cultivate accurate communication skills, such as conveying one's thoughts to others, which is considered necessary for various tasks such as remote work, which is expected to increase in the future.

Keywords: *New Era with COVID-19, Interactive Experiment Notebook, Student Experiment, Science Literacy, Active Learning*

Introduction

In the field of science and engineering education, many experiments are conducted by students in order to understand laws and acquire related techniques. In that sense, student experiments are largely training in nature, and fundamentally have a passive nature. Students' evaluation of experimental subjects is mainly based on the reports submitted by the students, but no systematic guidance is provided on the lab notes that form the basis of the reports. However, for science and engineering students, it is important to write in the experiment notebook, which is the basis of the report. However, despite its importance, there has been no systematic guidance on laboratory notebooks. Therefore, we have been conducting research on systematic experiment note-taking instruction in science and engineering education (Koshiji, 2015, 2016 and 2017). Now, this time, we tried the following two points. That is, (1) Adoption of Risk Prediction Sheet (KY-Sheet) for student experiments, (2) Trials of remote experiments and utilization of the accompanying electronic bulletin board. These matters will be described in detail below..

Adoption of Risk Prediction Sheet (KY-Sheet)

In modern society, in recent years, various unexpected things have happened in which conventional experience and know-how do not apply. Specifically, in Japan, the 2011 Great East Japan Earthquake, the nuclear power plant accident induced by the earthquake, and the frequent torrential rain disasters correspond to this. Globally, the global spread of COVID-19 infection and the spread of Conversational AI are thought to correspond to this. In such an unpredictable era, engineers need to rationally understand various elements on a fact-based basis, have an awareness of the issues, anticipate responses, and work on the issues. Therefore, engineers in the future will have to tackle problems with a PBL perspective and response more than ever before. PBL education and active learning have been advocated as training for this purpose. Through these, cognitive, ethical and social abilities, culture, knowledge, experience, etc. are nurtured. However, in order to do so, it is necessary to prepare the optimal environment for carrying out group work, and furthermore, it is necessary to carefully select the subjects for these efforts. On the other hand, in our approach, we were able to change the passive student experiment into a place for PBL education and active learning just by changing the viewpoint 180 degrees while maintaining the basics of conventional student experiments. The specific contents are described below.

Currently, at construction sites in Japan, “KY-Boards” (or “KY-Sheets”) are used to clarify the types of dangers that can be expected in the work to be done on the spot and how to deal with them. Here, KY is an acronym for “Kiken Yochi (japanease) “= “Risk prediction”. Figure1 shows the appearance and details of the KY board that is actually used in Japanese factories and construction sites.

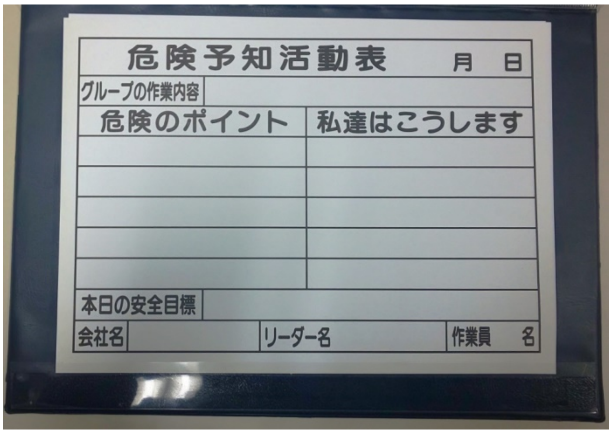


Figure 1 KY-Sheet（Risk Prediction Sheet）The sheet contains items such as the date, work content, dangerous items and countermeasures, safety goals for the day, leader name, number of people working, etc.

This time, we adopted the format of this KY-Sheet into the student experiment. Specifically, before conducting experiments, students should read the experiment manuals and reference materials as necessary to understand the content. After that, the students will pick up matters to be kept in mind or conscious of during the experiment (mainly safety aspects, including how to proceed), think about countermeasures by themselves, and write these on the KY sheet (Figure2). Therefore, the format adopted this time includes a wider range of content than the conventional KY sheet, which focused on safety. Then, the experiment leader summarizes the contents of the sheet individually filled in by the experiment team members as the team's opinion, creates a "team KY sheet"(Figure3), and displays it during the experiment. As a result, students could conduct experiments safely, and at the same time, students' experiments, which had a passive nature, could be tackled as a place for active learning.

2023　年度　電気電子実験2　KYシート　Ver. 2

【日付】

【グループ名(記号)】　グループ(　　)

【氏名】4E　(　　)番(　　　　　　)

【実験テーマ名】

実験で注意するポイント（とくに安全に関して）	それに対する対応	備考

Figure 2　KY sheet for individual students (partial excerpt) The sheet contains the date, group name, student name, experiment theme name, points to note in the experiment, response to it, and remarks.

2023 年度　電気電子実験2　KY シート　Ver. 2　チーム用　【日付】西暦　　年　月　日(　曜日)　安全や危険対応については赤字で

【チーム名／学生氏名全部】　チーム(　　　)

【実験テーマ名】

実験で注意するポイント	それに対する必要とされる対応	備考

Figure 3　KY sheet for team（partial excerpt）This sheet contains the same items as shown in Figure 2.

Trial of Remote-style Student Experiment

Since 2019, the COVID-19 pandemic has started around the world. In Japan, the first infected person was reported in 2020. Since then, there have been several peaks of infection in Japan, and the lives of the Japanese people have been greatly affected. “Avoid the Three Cs (Closed spaces with poor ventilation, Crowded places with many people nearby, Close-contact setting such as close-range conversations) “were advocated in Japan as well as overseas. And social distance was advocated as one of the means. Now, in the electrical and electronic experiments that are the subject of this research, students gather in a small laboratory and use various devices at the same time, so crowding, close contact, and contact between students is inevitable. Therefore, in order to keep a certain social distance, we tried a remote experiment. The contents are as follows.

An experimental group consisting of four students is divided into two groups. The first group will be the "instruction analysis group", which conducts experiments and analyzes in the HR classroom, which is separate from the laboratory. The second group will be called the “experimental group,” which will actually conduct experiments in the laboratory. Then, the two teams will communicate with each other through the remote meeting tool, Microsoft Teams, and carry out the experiments while cooperating with each other (Figure 4).

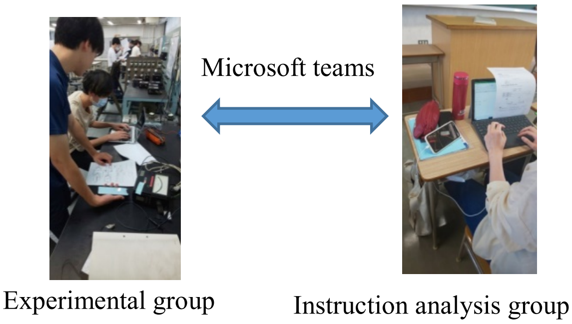
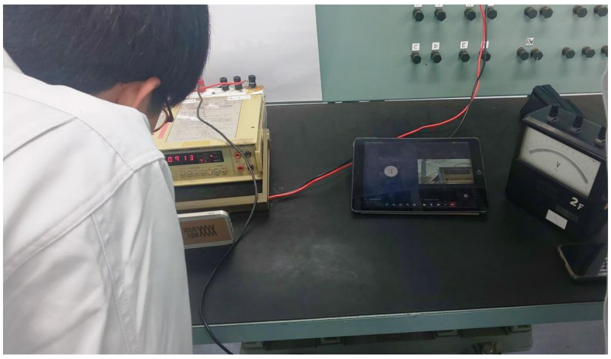
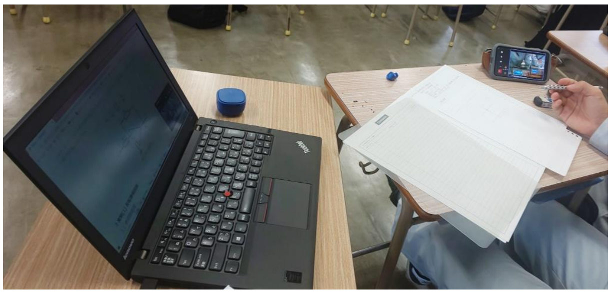


Figure 4 Conceptual diagram of remote experiment

Figure 5 shows the situation of each group. Each experimental group conducts experiments by communicating with each other while devising video chats, voice chats, sending images, etc.



(a)



(b)

Figure 5 (a)” experimental group”: Laboratory side in remote experiments (b) "instruction analysis group”: Home Room side in remote experiments

After the analysis team performs a simple analysis on the collected data, it is saved in Microsoft OneNote, shared with the team and with the instructor, and undergoes final checks. By using such a remote meeting tool, we were able to try remote experiments while maintaining social distance.

Grasping the time series of experiments and exchanging opinions using a web bulletin board

This time, Microsoft Teams was adopted for the student experiment in order to conduct the remote experiment as mentioned above. Using this communication tool, we conducted a trial of a web bulletin board for reporting/posting the progress of each experiment team's experiments, and for openly posting any troubles that occurred or problems that they had.

By the way, in this student experiment, multiple instructors are assigned to multiple laboratories and provide guidance. No TA was employed to advise individual experiments. Therefore, each faculty member cannot grasp the individual details of each experiment in real time. Now each experiment consists of a series of multiple mini-experiments. However, due to the placement of instructors as described above, the instructor can grasp the time series of the start and end of the entire experiment. On the other hand, it is impossible to grasp the timing of the start and end of small experiments (including the time required for preparation wiring). Therefore, we asked the student team leaders to post the start and end of each small experiment and the timing of preparations such as wiring changes on this WEB bulletin board as appropriate. Through this attempt, the instructor was able to grasp the detailed chronological order of each small experiment. Furthermore, by projecting the images of the web bulletin board on a large-scale display separately placed in each laboratory, each instructor and each student can easily check these at any time (Figure 6). As a result, information such as “Each small experiment or preparation took longer than expected by the instructor" or “The work was completed in an unexpectedly short amount of time" can be understood. This will provide basic data for future revisions or changes to the experiment. At the same time as reporting to the WEB bulletin board, we asked the students to write down their troubles and difficulties on this WEB bulletin board in real time. As a result, it has become possible to record the voices of students, who are difficult to record in lab notebooks and reports, and to use them to improve the contents of future experiments.

Figure 6 Web bulletin board projected on a large display in the laboratory

Results and Discussion

(1) This time, by using the KY sheet, we were able to turn the student experiment, which has a strong passive element, into a training ground for the student who is an engineer's egg who lives in an unpredictable age. In addition, we conduct a questionnaire for students asking what kind of items should be added to this KY sheet for better experiments. Based on the results, we will create better KY sheets and strive to foster awareness that students themselves are participating in the planning and management of student experiments.

(2) We tried a remote experiment as an emergency evacuation response to the corona disaster. In Japan, on May 8, 2023, COVID-19 will be treated as a normal infectious disease, and the COVID-19 disaster is converging on the surface. However, we still cannot afford to be complacent about the COVID-19 disaster. Also, even after the COVID-19 pandemic is over, the importance of remote work in the engineering field is expected to increase in the future due to reasons such as the shortage of skilled engineers, globalization, and the sophistication of technology. In that sense, the know-how obtained from this remote experiment is considered to be useful information. Also, this time it was a remote experiment on the premise that there was a working student in the laboratory. On the other hand, remote experiments in a completely remote environment are also envisioned. That is, the laboratory is unmanned, and the experiment operates the equipment from a completely remote situation. Of course, it will not be possible to realize remote experiments in all experiments. However, there is a possibility of realization in the electronic experiment dealing with electronic equipment. Currently, we are paying attention to the "Node-RED" system as a tool that may be able to realize remote electronic experiments. Learning this deeply, we would like to work on remote electronic experiments as student experiments.

(3) This time, we set up a virtual WEB bulletin board on Microsoft-Teams. By utilizing the immediacy of ICT and utilizing this WEB bulletin board, we were able to collect information on the progress of experiments, questions that arose, and problems that arose from students conducting experiments. Furthermore, I would like to explore the possibility of communication between instructors and students and between students in student experiments by using the reciprocity of ICT.

Conclusions

In this trial, by trying an active and interactive approach, we were able to stimulate the students' positive attitudes and awareness, and also enabled close information sharing between instructors and students. Through these attempts, we were able to foster scientific literacy. Through these attempts, I was able to transform from a "passive experiment" to an "active experiment." We hope that this attempt will help cultivate engineers who will open up the unpredictable after-covit19 era.

Acknowledgements

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